## Menlo Park Notebook #84 [N-80-01-02.4]

This notebook covers the period January-May 1880. Most of the entries are by Francis Upton. There are also a few entries by Edison. The first 53 pages contain a record of experimental lamps burning at Menlo Park in January 1880, which was kept by one of the laboratory assistants, possibly Albert Herrick. The remainder of the book consists primarily of calculations by Upton about electric lighting. There are also a few notes and calculations relating to electric meters and a few drawings of lamps, including some by Edison. The label on the front cover is marked "Record Condensed," "Lamps," and "Herrick." The book contains 288 numbered pages.

Blank pages not filmed: 80-83, 94-125, 130-286.

Missing page numbers: 1-8, 37-38, 43-44.

No 84.

LIBRARY OF THE

BOARD OF PATENT CONTROL,

120 BROADWAY, NEW YORK.

[illegible]

~~GENERAL ELECTRIC~~

[illegible] N.Y. C.

[illegible], 189 6.

| No of Lamps | before Heating Res | Date Put up | Date Busted | hours burned | [illegible] | Page |
|---|---|---|---|---|---|---|
| 142 | 150 | Jan 2 | Jan 13 | 404½ |  | 1 |
| 187 | 149 | Jan 2 | Jan 17 | 217 |  | 3 |
| 275 | 142 | Jan 2 | Jan 2 | 21 | * | 4 |
| 167 | 136 | Jan 2 | Jan 2 | 2.50 |  | 9 |
| 208 | 142 | ″ 2 | ″ 3 | 22 |  | 11 |

| No. of Lamp | Res. before test | Date put up | Date Burnt | Total hours burned | Position of Burst | Page | Remarks |
|---|---|---|---|---|---|---|---|
| 186 | 155 | Jan 2 | Jan 3 | 37<br>204 | | 21 | |
| 211 | 159 | Jan 2 | Jan 2 | 176 | | 22 | |
| ~~147~~<br>147 | 145 | " 2 | " 2 | 88 | | 23 | Upto 8 gas jets |
| 198 | 117 | " 2 | " 15 | 279 | | | |
| 143 | 136 | " 2 | " 6 | 32 | | 20 | |

| No. Lump | Reo after H. | Date Com. & burn | Date Burst | Time burned | Position of Bulk etc. | Page | Remarks |
|---|---|---|---|---|---|---|---|
| 236 | 130 | Jan. 2 | Jan 5 | 52.55 ~~2.44~~ | | 24 | |
| 218 | 157 | " 2 | " 2 | 45.00 | | 25 | |
| 248 | 135 | " 2 | " 3 | 43.00 | 6 | 26 | |
| 222 | 147 | " 2 | " 2 | 47.00 | 7 | 27 | |
| 257 | 160 | " 2 | " 5 | 77.05 | | 28 | |

| No. of Lamp | Res. after | Date put up | Date Broke | Time have burned | Position of Electric | Page | Remarks |
|---|---|---|---|---|---|---|---|
| 206 | 142 | Jan 2 | Jan 2 | 44 | | 30 | |
| 210 | 127 | " 2 | " 8 | 60 | | 34 | Arch formed at Clamps |
| 163 | 135 | " 2 | " 8 | 74 | | 35 | |
| 196 | 117 | " 2 | " 2 | 60 | | 36 | |
| 235 | | " 2 | " 5 | 46 | | 39 | |

| No of Lamp | Reo before # | Date last Insp | Date Broken | Total hrs burned | Position of Box | Page | Remarks |
|---|---|---|---|---|---|---|---|
| 229 | 145 | Jan 2 | Jan 2 | 45:00 | 1 | 40 | |
| 301 | before # 229 | " 5 | " 5 | 56.20 | | 46 | Specially Criticised by E. on P 57 |
| 303 | before # 265 | " 2 | " 2 | 1 | | 47 | Specially Criticised by Edison on P 59 |
| 244 | | " 2 | " 2 | 1 | | 48 | |
| 300 | 145 | " 2 | " 3 | 48 | | 53 | |

| No. of Lamp | Ho. before Heating | Date | and | burning | When Broken | Date | Total | hours | Ratio of cases | Page |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 493 | Broke | by | bumping | up | from | Glass Tumor small carbon |  |  |  |  |  |
| 462 | 375 | Too feeble |  | light | – | Further experiment - varies |  |  |  |  |  |
| Jan. Illume, Bank note small carbon enameled |  |  |  |  |  |  |  |  |  |  |  |
| wrapped in white paper |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 608 | Jan 28 | 1880 | glass | broke and allowed the man to |  |  |  |  |  |  |  |
| cross for Chem. Laboratory |  |  |  |  |  |  |  |  |  |  |  |
| a |  |  |  |  |  |  |  |  |  |  |  |

| No of Lamps | Rec before Heating | Elec. Cur. turning | Bulb Bursted | Total hours | Position of Neck | Page | |
|---|---|---|---|---|---|---|---|
| 311 | | Jan 3 | Jan 5 — | 43.50 | | 55 | |
| 307 | | Jan 8 | Jan 28 | 336. | | 57 | |
| 306 | 187 | Jan 8 | Jan 3 | 28.10 | | 58 | Carbon oxydized |
| 295 | 137 | Jan 3 | Jan 3 | .01 | | 59 | Broke in one Instant |
| 310 | 140 | Jan 3 | Jan 3 | 6.00 | | 60 | |

| No of Family | Rec. after Hearing | Date permit | Date Treated | Time hours consumed | Position of Rack | Page | Remarks |
|---|---|---|---|---|---|---|---|
| 8/2 | 142 | Jan 3 | Jan 5 | 42.45 |  | 61 | Broke by Jan 20 thought — |
| 2/4 | 195 | Jan 3 | Jan 2 | 244.05 |  | 62 |  |
| 240 | 124 | Jan 5 | Jan 9 | 102.29 |  | 63 |  |
| 264 |  | Jan 4 | Jan 14 | 189. |  | 65 |  |
| 284 |  | Jan 2 | Jan 4 | 13.4 |  | 64 |  |

| No. of Lamp | [illegible] | Date put up | Date broken | Total hours | No. of [illegible] | Page | Remarks |
|---|---|---|---|---|---|---|---|
| 265 | 247 | Jan 3 | Jan. 13 | 157.28 | 7 | 67 | |
| 223 | | Jan 4 | Jan 4 | 1.40 | | 69 | |
| 104 | 126 | Jan 4 | Jan 5 | 26.57 | | 70 | Old Clamps Badly oxydized |
| 328 | 135 | Jan. 4 | Jan 5 | 28.00 | | 71 | |
| 315 | 230 | Jan 5 | Jan 9 | 124.52 | | 72 | |

26

| No of Lamp | Res before Heating | Date put up | Date Burn- | Total hours | Position on circuit | Page | Remarks |
|---|---|---|---|---|---|---|---|
| 316 | 185- | Jan 5- | Jan 13 | 146.0 |  | 73 |  |
| 317 | 144 | Jan. 5- | Jan 5- | 16.47 |  | 74 |  |
| 318 | 152 | Jan 5 | Jan 7 | 25 |  | 75 |  |
| 325 | 143 | Jan 5- | Jan. 9 | 77.40 |  | 79 |  |
| 327 | 180 | Jan. 5 | Jan 5- | 15.47 |  | 80 |  |

27

| No. of Lamp | Ro. ~~off~~ Heating | Date when put up | Date when Burned | Total hours burned | No. of Break | Page | Remarks |
|---|---|---|---|---|---|---|---|
| 322 | 150 | Jan 5 | Jan 9 | 77.48 | | 81 | |
| 330 | 140 | Jan 5 | Jan 5 | — | — | 84 | Busted immediately Irregular thickness of Glass. |
| 332 | | Jan 5 | Jan 6 | 50.40 | — | 86 | |
| 184 | 145 | Jan 6 | Jan 10 | 184.20 | 1 | 95 | |
| 357 | | Jan 7 | Jan 9 | 38.15 | — | 104 | Inside Glass Cracked |

| No. of Lamp | Res. before after Heating | Date put up | Date Broken | Total Hours | Per. of Break | Page | Remarks |
|---|---|---|---|---|---|---|---|
| 358. | 130 | Jan 8 | Jan 9 | 27.40 | [illegible] | 105 | Glass Cracked on leading |
| Ion | | | | | | | |
| 362 | 172 | Jan 8 | Jan 8 | 15:00 | | 107 | Glass Cracked on leading-in wire |
| 368 | 127 | Jan 8 | Jan 10 | 54.00 | | 108 | " " " |
| 361 | | Jan 9 | Jan 9 | 1.00 | | 109 | " |
| 571 | | Jan 9 | Jan 9 | 13.40 | | 110 | Carbon broke near Clamp also |
| Crack in glass | | | | | | | |

| No of Lamp | Res. after Heating | Date put up | Date Busted | Total Hours | [illegible] | Page | |
|---|---|---|---|---|---|---|---|
| 376 | . | Jan 9 | Jan 12 | 38.55 | | 114 | One of The Experiment |
| [illegible] | bent in top | | | | | | |
| 325 | 145 | Jan. 9 | Jan 9 | 11.00 | 7 | 124 | |
| 394 | 105 | Jan 9 | Jan 12 | 4.00 | | 129 | Glass Busted |
| 377 | 129 | Jan 13 | Jan 13 | 8.00 | | 130 | |
| 410 | 124 | Jan 14 | Jan 14 | 4.00 | | 131 | |

| No of Lamp | Rev before Burning | Date Put-up | Date Burned | Total Hours Burned | Total Hours | Page |
|---|---|---|---|---|---|---|
| 401 | 118 | Jan 14 | Jan 14 | 8.00 | | 132 |
| | | | | | | |
| 159 | 153 | Jan 2 | Jan 30 | 6~~7~~6.45 | | 1 |
| 223 | 140 | Jan 2 | Jan 19 | 367 | | 8 |
| 108 | 141 | Jan 2 | Jan 25 | 445 | | 21 |
| 153 | 132 | Jan 2 | Jan 17 | 406 | cc | 23 |

after this look in book 74

| No of Lamp | Resis. after Heating | Date put up | Date Busted | Total hours | No. of Book | Page | |
|---|---|---|---|---|---|---|---|
| 224 | 109 | Jan 2 | Jan 29 | 134.30 | . | 25 | Glass broke bump case |
| 181<br>contact | 152 | Jan 2 | Jan 27 | 429 | | 31 | Carbon broke at clamps bad |
| 307 | 242<br>~~[illegible]~~k | Jan 3 | Jan 27 | 336 | . | 223 | and 35 |
| 398 | | Jan 2 | Jan 26 | 257 | 1 | 44 | Carbon broke |
| 184 | 145 | Jan 6 | Jan 17 | 948 | 7 | 55 | Carbon broke |

| No of Lamp | Rec- [illegible] Reading | Date put up | Date Broken | Total hours | Pos. Break | Page | |
|---|---|---|---|---|---|---|---|
| 373 | 125 | Jan 9 | Jan 24 | 262.15 | 7 | 65 | Carbon Broke |
| 353 | 155 | Jan 5 | Jan 29 | 429. | | 79 | |
| 323 | 114 | Jan 10 | Jan 20 | 173 | | 81 | |
| 395 | 141 1/2 | Jan 12 | Jan 29 | 171 | | 89 | |
| 155 | 126 | Jan 2 | Jan 8 | 562.14 | 1 | 59 | |

| No of Lamp | Res. after heating | When put-up | When Burned | Total hours | Note Book | Page | |
|---|---|---|---|---|---|---|---|
| 360 | 125 | Jan 12 | Jan 26 | 360. | 7 | 99 | |
| 431 | 130 | Jan 17 | Jan 29 | 1823.5 | 10 | 109 | |
| 432 | 152 | Jan 10 | Jan. 26 | 183 | 13 | 113 | |
| 410 | 117 | Jan 17 | Jan 29 | 198 | | 14 | |
| 435 | 150 | Jan 20 | Jan 20 | 8 | 5 | 123 | Small Carbon E. |

| No of Lamp Box | Res. after H | Date pur-chsd | Date Broken | Total Hours | Pos. of Break | Page | |
|---|---|---|---|---|---|---|---|
| 437 | 152 | Jan 20 | Jan 20 | 7.40 | | 125 | Defect in paper |
| 436 | 127 | Jan 28 | Jan 20 | 2.00 | | 127 | |
| 437 | 152 | Jan 20 | Jan 20 | 4.00 | | 131 | Small Carbon |
| 498 | 155 | Jan 20 | Jan 20 | 200 | 3 | 133 | Small " |
| 443 | 142 | Jan 20 | Jan 20 | .24 | 5 | 131 | " " |

50

| No. of Lamp | Rec. of Testing | Date put up | Date Broke | Pos. of Carbon | Page | Noted here | Cause |
|---|---|---|---|---|---|---|---|
| 444 | 138 | Jan 20 | Jan 20 | .23 | | | |

563 Wire melted off at the solder ~~before being used~~ Hung up by organ on wires on Feb 1. 11.55 – Rec 164.

552 Res 350 Enamelling broke by leading wires Edison saw Burst Ext. fibre

51

| | | | | | |
|---|---|---|---|---|---|
| No of Lamp | | | | | |
| Res. after Heating | | | | | |
| Date when put up | | | | | |
| Date when Burnt | | | | | |
| Total hrs | | | | | |
| Pos. of contact | | | | | |
| Page | | | | | |

Place

```
  67        85
  67        85
 ----      ----
 469       425
402       680
 ----      ----
4489      7225

 71         81
5041.      6561
```

```
4489) 7225 (1.6          18.9
      4489                1.6
      -----             ------
      27360              1134
      26934              189
      -----             ------
       4260             30.24
                    30.24 Candles
```

```
~~6561) 5041~~                 18.9
   5041) 6561 (1.3              1.3
         5041                  -----
        ------                  567
         15200                 189
         15123                 -----
        ------                 2457
            77
```

100
28.5
715

81~~225~~) 511 (~~225~~ 6.3
486
250
243
70

2
12.6

30 70
900) 4900 (54
4500
4000
3600
4000

2
10.8

100
27.6
72 4

20.6
794

76 ~~176~~) 524 (~~6~~9 524 176
456
8

2
138

42436

63 0436

42) 63.0 (1~~5~~
42
210
210

Let x = one distance
100 − x = other

$x^2 = \frac{3}{2}(100-x)^2$

$= \frac{3}{2}(10000 - 200x + x^2)$

$= 15000 - 300x + \frac{3}{2}x^2$

$\Rightarrow x^2 \mp 600x = -30000$

$x^2 \mp 600x + 90000 =$ ~~[illegible]~~ 60000 ft

$x \mp 300 =$ ~~[illegible]~~

$x^2 = \frac{3}{2}(100-x)^2$

$2x^2 = 3(10000 - 200x + x^2)$

$= 30000 - 600x + 3x^2$

$x^2 - 600x = -30000$

$x^2 - (\ ) + 90000 = 60000$

$x - 300 = \pm\sqrt{60000}$

$x = 300 \pm \sqrt{60000}$

$x = 600$

544

100
244
756

3.600
1600

244
756

344
456

59536 ) 371536

$x^2 : (100-y)^2 :: 1\frac{1}{2} : 1$
$= 3 : 2$

$x^2 = \frac{3}{2}(100-x)^2$

$2x^2 = 3(10000 - 200x + x^2)$

$x^2 - 600x = -30000$

2079) 29593~~6~~ (14
2079
8800

$10000 \qquad -200X+2x^2$

$X^2 = 2(100-x)^2$

$x^2 = 20000 - 400X + 2x^2$

$X^2 - 400x = -20000$

$x^2 - (\ ) + 40000 = 20000$

$x - 200 = \pm 141$ 341

$X = 341$

$100 - x = 65.9$

$$\begin{array}{r} 200 \\ 141 \\ \hline 59 \end{array}$$

1162)4251( 41

$+ \quad x) \quad 1 \quad (100 - x$

1681)3481(
3362

2X2 59
41

$X^2 = 3(100-x)$

$x^2 = 30000 - 600x + 3x^2$

$2x^2 - 600x = -30000$

$x^2 - 300x = -15000$

$x^2 - (\ ) + 150^2 = 22500 - 15000 = 7500$

$x - 150 = \pm\sqrt{7500} = \pm 86$

$x = 150 - 86 =$ 64

$100 - x = 36$ 64

1296)4096(3
4088

3X2 64
36

$x^2 = \frac{5}{2}(100 - x)^2$

$2x^2 = 50000 - 1000x + 5x^2$

$3x^2 - 1000x = -50000$

$x^2 - 333x = -1,66,66$

$x^2 - (\ \ ) + \left(\frac{1666}{\cancel{8}}\right)^2 = 27556 \cdot 16666$

$= 108,90$

$x - 1666 = \pm 104.8$

$x = 1666 - 104.8 = 61.8$

$\cancel{7}\frac{1}{2} \times 2$

61.8

38.2

729 ) 5329 ( 73

5096

2330

14.6 candles

27

~~7~~ 3

~~729 ) 3969 ( 5~~

~~3635~~

~~3340~~

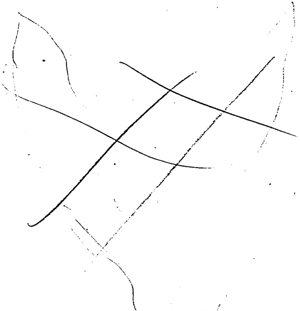
729 ) 5329

14.6 candles

207
793

428)6288(12
428
1008

24 candles



24 candles

38.2   1459

618   3819

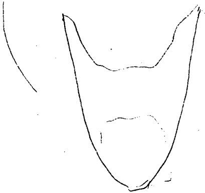
1459)3819(2.7

2818

10010

10213

5.2 Candles



5.2 candles

$$x^2 = 8(100 - x)^2$$

$$x^2 = 80000 - 1600x + 8x^2$$

$$7x^2 - 1600x = -80000$$

$$x^2 - (\ ) + (228.5)^2 = -11428 + 52200$$

52441

51984

52200

11425

40772

$$x - 228.5 = -201.8$$

$$x = 26.7$$

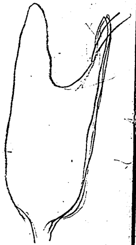
$$100 - x = 73.3$$

68

367
633

1346 ) 4006 ( 3
~~[illegible]~~
4038

[illegible] candles



6 Ca[illegible]

---

Electric Light 69

297 882
703 4942

882 ) 4942 ( 5.6
4410
5320

11 Candles

Flat side

---

393 1544
607 3684

1544 ) 3684 ( 2.3
3088
5960
4632
13280

4.6 Candles

Side

305 92500
695 483025

925)4830(5,2
4615
2150

10,4 Candles

---

30 900
70 4900

9~~00~~)49~~00~~(
544
10.88.

20 400
80 6400

16 candle

19,5 38025
80.5

Placed candles in box of galvanometer

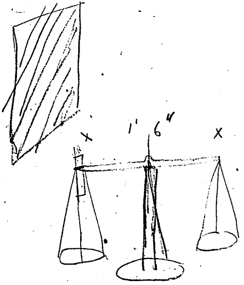
28.8
71.2

28.8
28.8
2304
2304
576
82944

71.2
71.2
1424
712
4984
506944

829)5069(6.8
4374
7250

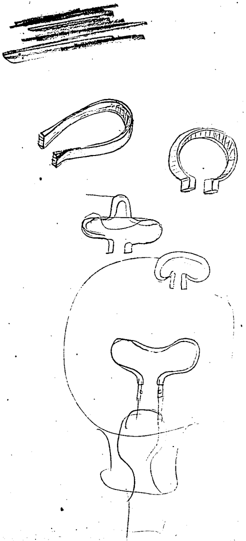
13.6 Candles
10.8
Difference due to box 2.8 candles



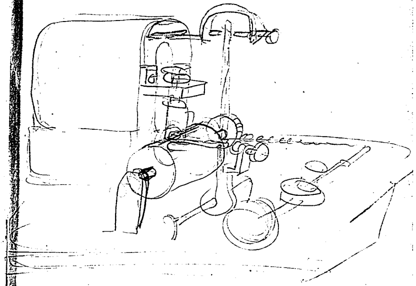
Have 4 boards
30" X 30"

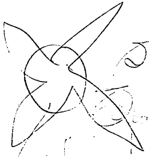
Two blackened on one side
Two " " both sides
with lamp black and alcohol
and just enough shellac
to make it stick and
give a dead black

surface



March 5 1880





Spain Spain,

Spain Spain

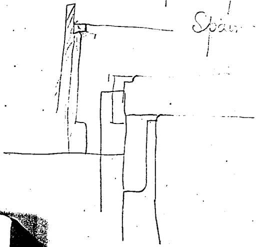
Ferrol

Ferrol

Ferrol in Spain

Spain Spain Spain

Spain Spain



1,3 in. side

3.62

7 8

39:

4.68 sq. in surface

8 | 5.10

62

cu in

~~Gr~~ 11 3/5 jar capacity (small)

2 7/8 in apart

---

First Experiment —

Two plates wt. 10 ~~grms~~ grams each. in solution moderately strong for 20 hours

after charging 20t in storage battery

Weight the carbon pole

grms.

wt 5 125 grains

grms

Zinc pole 13 15 grains

19 12 loss 3 ~~2~~ grms

total wt grms

dif. 8 2.5 grains

grms

8 2.5 grains in 20 hours

2 7/8" apart

1 1/4" width surface

3 5/8 depth

2 7/8 X 1 2/8 X 3 5/8 cub contents

small jar

Cub. contents Large jar

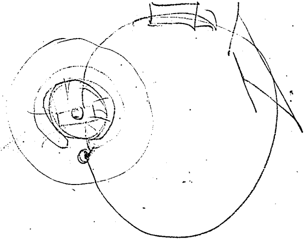
Br 1 4/8

Length = 3 7/8

Depth 4 7/8

Cap 1 4/8 × 3 7/8 × 4 7/8 = 28 1/5

28 1/5 internal capacity large jar inside



Small Pail II

3/4 in side in ditto jar

3/4 × 3 5/8 in surface

Both nearly the same width

.2680 sq. ins

Large plate P.M. 10.30 May 19 1880

1 3/8 × 4 1/8 = X

1 3/8 × 4 1/8

$\frac{11}{8} \times \frac{33}{8} = \frac{363}{8}$   $\frac{33}{33}$

64/ 363 (5 — 6/3.59 in surface

320

43   6/9 Large plates

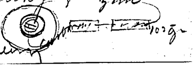
44

May 19 [illegible] P.M.

Large and small jar in zinc

small [illegible]

firm [illegible]



Small jar

Both

Jt- Small Plates 45.9 gr.

45.9 Pos. 16.5 grains

45.9 / 91.8 Neg. 75.4 gr / 16 / 91.4

Dif .4 grains

~~Large jar~~

188.2

Jt- ~~188~~ 188.2 grains zinc

94.1 " copper

282.3

65.7 grains Light afterwards

217.4

~~283~~ 283.1

282.3

.8 dif

217.4
188.2
29.2

Floated plates from zinc poles

Inc. 30.2 grains in 12 hours
Small Plate
Inc. 29.2 grains in 12 hours
Large Plate

24/34 = 14/17 -

30.2

Value per m. = 19.56 mg grain.

30.2
217.3 grains in 12 hours 95 grains

372 / .472

19.56
60
1173.60 mil. grams

12
60
720

372 / .4

.01956 grains
720

324. / 424 = 162 / 2017 9 5101
720
39120
13692
14.08320

14.08320.
15.43
422496
563328
704060
140832
217.3937776

217.3

grains depos. x
Total time x
grains to be depos.
with 1 Weber per
12 hours

30.2 . 12 . 217.3

30

30~~2~~
217.~~3~~

217 ) 30.000000 ( .13824
217
830
651
1790
1736
640
434
1060
~~868~~
192

Weber
.13824
per 1 m.

[illegible]
217.3 grains per ~~thirtieth~~
constant current of 1 Weber per
minute

gr. gr.
30.2 : 217.3 :: 19.06 ~~x~~

30

30.2 / 217.3 = of Weber.

217
1

217.3
1756
13038
10868
19157
~~2~~2173
30.2 ) 420 0.3588 ( 139.3
302
1190
906
2842
2708
1158
906
2528
2416
112

.13824
217
96768
13824
27648
3009808
106
30.09914

Thick copper for large
Jar $\overset{gr}{38}$ 12 grains
$\underline{\phantom{0}2}$
76 24

$2\,\underline{)\,74\text{ grams}\ \ 11,50}$
37. 5.75

37 5.75 not correct
Plates for large
Jar both same

small plates for
04 jar

Cu $\overset{gr}{31}$. 7 grams zinc Plate

$\overset{grams}{10}$ . 7 gr carbon
$2\,\underline{)\,31.0\ \ 7.0}$
15.5 3.5
7
$\overset{gr}{15}$. $\overline{10,5}$

Experimental Lamps

No. [illegible] = 2 1880

V. 650 R. 890

Fiber [illegible]
not enameled ~~R[illegible]~~ clamps
~~with~~ ~~little~~ platinum in the [illegible]
between [illegible] [illegible]
[illegible] 5.00 4.15 = 2.00

Broke at 2.45.

Total 1.00
" 5
" 1.45
7.45

Peculiar break arch formed between clamps fiber laying in bottom of globe

No 591 Res. 350
on base of Batchelors desk Lab
Commenced Burning on A
fiber Carbon
Graphite clamps

Carbon wedged in with
small pieces Clamps smaller
and finished and is done

Commenced | Feb 4 1880
burning a/c | 6.00 AM

1087.40 Burnt 50 minutes

Peculiar break ash formed
between clamps fine on bottom